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[0001] CONSERVATION OF ACCESS NETWORK BANDWIDTH DURING MULTIUSER CALL CONNECTIONS IN A BROADBAND TELEPHONY NETWORK

[0002] BACKGROUND

[0003] The invention generally relates to broadband telephony networks. In particular, the invention relates to routing telephony connections in a broadband network.

[0004] Figure 1 illustrates a telephony network 10. Telephone users of the broadband network use telephones 12_1 to 12_n connected to communication gateways (CGs), 14_1 to 14_m, to make telephone calls. The CGs 14_1 to 14_m are used as an interface between the telephones 12_1 to 12_n and the rest of the network 10.

[0005] The CGs 14_1 to 14_m are connected to an Internet protocol (IP) network 18 through a cable modem termination system 16 interfacing between the CGs 14_1 to 14_m and the IP network 18. The IP network 18 transfers packets of data. Each packet is sent in an assigned mini-slot of a frame in the network 18. Each packet carries communication data, such as encoded voice data, and overhead and routing data, such as a destination address.

[0006] The IP network is connected to the public switched telephone network (PSTN) 28 via a PSTN/IP network gateway 26. Telephone users 30_1 to 30_j using telephones outside the broadband network can communicate with broadband network telephone users 12_1 to 12_n through the PSTN 28.

[0007] The simplified hardware of a CG 14_1 to 14_m is shown in Figure 2. The CG 14_1 to 14_m has an RF connector 32 to receive RF signals from and transmit RF signals over the broadband network 10. A tuner/amplifier 34 and a cable modem 36 are used to convert the received RF signals into digital baseband signals and digital baseband signals into RF signals for transmission. The CG 14_1 to 14_m also has a digital signal processor (DSP) 38 and codec 40 for processing voice

signals. A processor 42 along with a random access memory (RAM) 44 and non-volatile memory (NVMem) 46 are used to perform many functions, such as performing commands as directed by the call management system 20.

[0008] To handle the overhead functions of the IP network 18, a network management system 22, an operating support system 24 and a call management system 20 are used. The call management system 20, "call agent", controls telephony calls sent through the network 18. If a call or a multi-party call extends over multiple networks call managers 20 in the different networks are used to facilitate communications between the networks. Typically, the party placing the call is the "control party" and its call manager 20 controls the call connections. Additionally, depending on the size and design of a network a single network may have one or multiple call managers 20.

[0009] The simplified hardware of a call management system 20 is shown in Figure 3. The call management system 20 comprises a call agent and a RF connector 48. The call agent 48 controls various functions of call management system 20 and interacts with other modules 22,24. Call signaling 50 sends commands to control components of the network, such as the CGs 14_1 to 14_m. Other components of the call management system 20 for use in performing its functions are the communications stacks 52, network interface module (NIM) 54, processor 58, RAM 60, non-volatile memory 62 and permanent storage 56.

[0010] One call agent function is to establish telephone connections between the telephone users 12_1 to 12_n. Figures 4a to 4d are a flow chart and illustrations of establishing a three-way telephone call. As shown in Figure 4b, a bi-directional connection is established between telephone user 1, T_1 12_1 and telephone user 2, T_2 12_2, 66. Each bi-directional connection has two opposing one-way connections. Each one-way connection in the network has an origin, a destination and at least one assigned mini-slot. Based on the bandwidth required for a connection and a network's allocation rules, multiple mini-slots may be assigned to a connection.

[0011] T_1 12_1 initiates a three-way call by placing T_2 12_2 "on hold" and placing a call to telephone user 3, T_3 12_3. As shown in Figure 4c, the "on hold" connection between T_1 12_1 and T_2 12_2 is maintained but inactive (as shown by dashed line). A bi-directional connection is established between T_1 12_1 and T_3 12_3, 68. When T_1 12_1 initiates a three-way call, both bi-directional connections (T_1/T_2 and T_1/T_3) are broken, deleted. Simultaneously, three new bi-directional connections are established to a network bridge 64 (T_1/bridge, T_2/bridge and T_3/bridge), 70. The network bridge 64 can be located anywhere within the telephony network 10, which includes the broadband network, the IP network 18 and the PSTN 28. One function of the network bridge 64 is to mix the messages from multiple users to be sent to one of the users. To illustrate for user T_2 12_2, all three users T_1 12_1, T_2 12_2 and T_3 12_3 send messages to the bridge 64. The bridge 64 sends the combined messages of T_1 12_1 and T_3 12_3 without T_2's message to T_2 12_2. Using the network bridge 64 eliminates the need for the telephone users 12_1 to 12_n to mix voice signals. For instance, T_1 12_1 does not need to send T_3 12_3 both T_1's and T_2's mixed voice signals.

[0012] Using the network bridge 64 also has drawbacks. When the T_1/T_2 and T_1/T_3 connections are broken, the network 10 may not have adequate bandwidth to establish the three new bi-directional connections. Initially, there are four one-way connections (two bi-directional connections) between T_1 12_1, T_2 12_2 and T_3 12_3. After establishing connections to the bridge 64, six (6) one-way connections (three bi-directional connections) are established requiring additional bandwidth for the two extra one-way connections. Furthermore, due to the mixing at the bridge 64, the connections originating from the bridge 64 may use higher rate voice coders requiring additional bandwidth. As a result, all of the connections may be lost. Accordingly, it is desirable to have alternate approaches to multi-user connection.

[0013] SUMMARY

[0014]A broadband telephony network changes a number of users in a multiuser call. The network initially has active users. Each initial active user has a one-way connection as an origin and a one-way connection as a destination. In response to a change in the number of users, for each active user maintaining an active status, the destination of one of the connections where that active user is the origin is changed while that active user remains as that connection's origin.

[0015] BRIEF DESCRIPTION OF THE DRAWING(S)

[0016] FIG. 1 is an illustration of a broadband telephony network.

[0017] FIG. 2 is an illustration of a communication gateway.

[0018] FIG. 3 is an illustration of a call management system/call agent.

[0019] FIG. 4 is a flow chart of establishing a related art three-way call.

[0020] FIGs. 4b to 4d are illustrations of establishing a related art three-way call.

[0021] FIG. 5a is a flow chart of three-way call connection.

[0022] FIGs. 5b to 5f are illustrations of a three-way call connection.

[0023] FIG. 6a is a flow chart of a multiuser call connection.

[0024] FIGs. 6b to 6f are illustrations of a multiuser call connection.

[0025] FIG. 7a is a flow chart of dropping a user from a three-way call.

[0026] FIGs. 7b to 7d are illustrations of dropping a user from a three-way call.

[0027] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0028] Figures 5a to 5f are a flow chart and illustrations of a three-way call connection. T_1 12_1 and T_2 12_2 are initially communicating and a bi-directional connection exists between T_1 12_1 and T_2 12_2, as shown in Figure 5b, 72. T_1 12_1 places T_2 12_2 "on hold" and that connection is maintained

but made inactive, as shown by the dashed lines in Figure 5c. T_1 12_1 initiates a call with T_3 12_3. A new bi-directional connection between T_1 12_1 and T_3 12_3 is established as shown in Figure 5c, 74.

[0029] To initiate a three-way call, T_1 12_1 sends a signal. The bi-directional connections between T_1 12_1, T_2 12_2, and T_3 12_3 are maintained but temporarily inactive. The network bridge 64 establishes a one-way connection from the bridge 64 to each telephone user 12_1 to 12_3 as shown in Figure 5d, 76. As shown in Figure 5e, the connections originating from each user 12_1 to 12_3 are rerouted to the bridge, 78. The one-way connection from T_1 12_1 to T_3 12_3 is routed to terminate at the bridge 64. Likewise, the one-way connections from T_2 12_2 to T_1 12_1 and T_3 12_3 to T_1 12_1 are rerouted to terminate at the bridge 64. The previous routing for the connections is shown by a dotted line. Since the user 12_1 to 12_3 of each rerouted connection is the same, the bandwidth requirements of each rerouted connection are the same. To reroute these connections, the call agent 20 simply directs that the destination addresses in the packets associated with the rerouted connections be changed. Voice communication between all three users 12_1 to 12_3 is then achieved through the bi-directional connections between the bridge 64 and each user 12_1 to 12_3. After the rerouting is completed, the unnecessary one-way connection between T_1 12_1 and one of the other users, such as T_2 12_2, is deleted, as shown in Figure 5f as a dotted line, 80.

[0030] The call agent 20 directs the rerouting of calls, the establishing and deleting of connections between the users 12_1 to 12_3 and establishing the bridge 64 using its call signaling 50, processor 58 and associated RAM 60 and instructions stored in its NVMem 62. The CG 14_1 to 14_m and bridge 64 perform the routing commands as directed by the call agent 20. The CGs 14_1 to 14_m will receive the downstream commands and perform the rerouting of its connections using their processors 42, associated RAM 44 and instructions stored in its NVMem 46.

[0031] One advantage to the approach of Figures 5a to 5f is that the routing complexity of the CG

14_1 to 14_m is reduced. The CG 14_1 to 14_m merely changes the destination of its transmitted packets instead of being assigned new packets and mini-slots. However, the complexity at the call agent 20 is increased due to the increase in routing.

[0032] If any of the new connections of Figure 5d cannot be made, the approach of Figures 5a and 5d allows for a graceful recovery. Since the initial connections between the users 12_1 to 12_3 are maintained while the bridge 64 establishes one-way connections between it 64 and the users 12_1 to 12_3, if any of the new one-way connections can not be established, the original connections between the users 12_1 to 12_3 can be reactivated. This approach reduces the chance that a call will be dropped.

[0033] One drawback to this approach is for a short period of time, seven one-way connections are required, as shown in Figures 5d and 5e. As a result, excess bandwidth is allocated for a short period of time. To eliminate the excess bandwidth allocation, the extra connection can be deleted at the same time the bridge establishes the three one-way connections, such as deleting the extra T_1 to T_2 connection, as in Figure 5f. As a result, only a maximum of six (6) one-way connections are required. However, only a graceful recovery between two of the users, such as T_1/T_3, is readily achieved. Due to the deleted extra connection, a graceful recovery between the other users, such as T_1/T_2, may not be possible. Accordingly, a trade-off between ease of recovery and allotted bandwidth is achieved.

[0034] The approach of Figures 5a to 5f can be applied to more than a three-way call, such as an n-way call. Illustrations and a flow chart of an n-way call using the approach of Figures 5a to 5f are shown in Figures 6a to 6f. T_1 desires to add an n^{th} user, T_n 12_n, to an existing n-1-way call. As shown in Figure 6c, an n-1-way call with connections to the bridge 64 exists. T_1 12_1 temporarily drops out of the n-1-way call, such as by performing a "hook flash," and establishes a bi-directional connection to T_n 12_n, as shown in Figure 6c, 84. T_1 12_1 initiates adding T_n 12_n to the call, such as

by a "hook flash" signal. A one-way connection from the bridge 64 to T_n 12_n is established, as shown in Figure 6d, 86. As shown in Figure 6e, the one-way connection from T_n to T_1 is rerouted to terminate at the bridge 64, 88. Subsequently, the excess connection is deleted, as shown in Figure 6f, 90.

[0035] Figures 7a to 7d are a flow chart and illustrations for dropping a user from a three-way call, such as T_2 12_2. As shown in Figure 7b, a bi-directional connection exists between each user, T_1 12_1, T_2 12_2 and T_3 12_3, and the bridge 64, 92. After T_2 12_2 hangs up the one-way connections from the bridge 64 to T_1 12_1 and T_3 12_3 are deleted, as shown in Figure 7c, 94. To connect T_1 12_1 to T_3 12_3, as shown in Figure 7d, the connection from T_1 12_1 to the bridge 64 is rerouted to terminate at T_3 12_3 and the connection from T_3 12_3 to the bridge 64 is rerouted to terminate at T_1 12_1. Since the bandwidth for the connections originating from each user 12_1, 12_3 are unchanged, the rerouting is simply performed by changing the destination address of the packets associated with the connections.

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